Coastal Optics and Mixing

W. Scott Pegau
College of Oceanic and Atmospheric Sciences
Ocean. Admin. Bldg. 104
Oregon State University
Corvallis, OR 97331-5503
Phone: (541) 737-4635 fax: (541) 737-2064 email: spegau@oce.orst.edu

J. Ronald v. Zaneveld
College of Oceanic and Atmospheric Sciences
Ocean. Admin. Bldg. 104
Oregon State University
Corvallis, OR 97331-5503
Phone: (541) 737-3571 fax: (541) 737-2064 email: zaneveld@oce.orst.edu

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LONG-TERM GOALS

The long-term goal of this study is to relate optical and fluid dynamic processes on scales of centimeters to tens of meters in the vertical.

OBJECTIVES

The objectives of this study are to address the following questions:
- Under what circumstances do the physical forcing mechanisms determine the optical properties and hence radiative transfer?
- Does mixing affect the dissolved and particulate components differently?
- Can the distribution of dissolved and particulate optical substances be used as tracers of physical processes?

APPROACH

During August 1996 and May 1997 we collected optical and hydrographic data at the Coastal Mixing and Optics (CMO) central site at 40.5° N 70.5° W. The data was collected with the Slow Descent Rate Optical Profiler (SlowDROP). Profiles of spectral absorption, scattering, and attenuation were obtained for both particulates and dissolved materials. Our approach is to analyze the optical and hydrographic data we collected during the two experiments, along with observations and data from other investigators. We are using the data to compare and contrast the relationships between the optical and physical properties during the spring and fall cruises as well as identifying interesting physical and optical features within each data set.

Dr. Bogucki has also been supported under this contract to assist Dr. Barth in processing and interpretation of the optical data collected on the SeaSoar platform. The intent is to ensure high quality data from that system, which can be used to determine the horizontal variability in optical properties that would affect the interpretation of optical measurements made at the central site.

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WORK COMPLETED

We have completed an initial analysis of the absorption by Colored Dissolved Organic Materials (CDOM). This analysis is to be presented at the Ocean Optics XIV conference by Dr. Boss (1999).

We participated in a workshop to determine interdisciplinary research topics based on the combined data sets of the investigators involved in the CMO project.

RESULTS

This project is a continuation of the Coastal Optics and Mixing project of Zaneveld and Pegau. Additional results can be found in that report. Based on analyses performed on the 1996 and 1997 SLOWDROP data we collected during the Coastal Mixing and Optics experiments, and with the collaboration of other investigators, we obtained the following results.

- The optical properties associated with a salinity intrusion observed during the 1996 experiment show evidence of redistribution by mixing (Figure 1). The absorption coefficient of dissolved materials has the clearest mixing line when plotted against salinity. Absorption by particulate matter also has a mixing line, but the scattering coefficient deviates from a mixing line near the peak of the salinity intrusion. These results indicate that mixing is important in the redistribution of optical properties in this case. There are still some processes other than mixing that must be accounted for if we are to understand the elevated scattering near the peak of the salinity intrusion.

- We have analyzed the CDOM component of the IOPs. Our data set is unique in that it resolves the whole water column, and includes both temporal (from seasonal to 10min sampling interval) and spatial information. Previous studies of CDOM in the Mid and South-Atlantic Bight have analyzed the near-surface spatial distribution and seasonal variability of CDOM (Nelson and Guarda, 1995, DeGranpre et al, 1996, Vodaceck et al, 1997). During our analysis we have identified a bottom source of CDOM associated with sediment resuspension that, to our knowledge, has not been previously observed. This affects the distribution of the absorption coefficient of dissolved materials (a_g). It was determined that the short-term variability in a_g was mostly due to conservative processes associated with advection (a_g was nearly constant along isopycnals). Over longer time periods (days and longer), sources and sinks of a_g result in a distribution that deviates from that of physical properties near the surface and near the bottom. The value of a_g in general decreases away from land and from the surface downward, this pattern is modified by photo-oxidation at the surface and a source near the bottom (Figure 2).

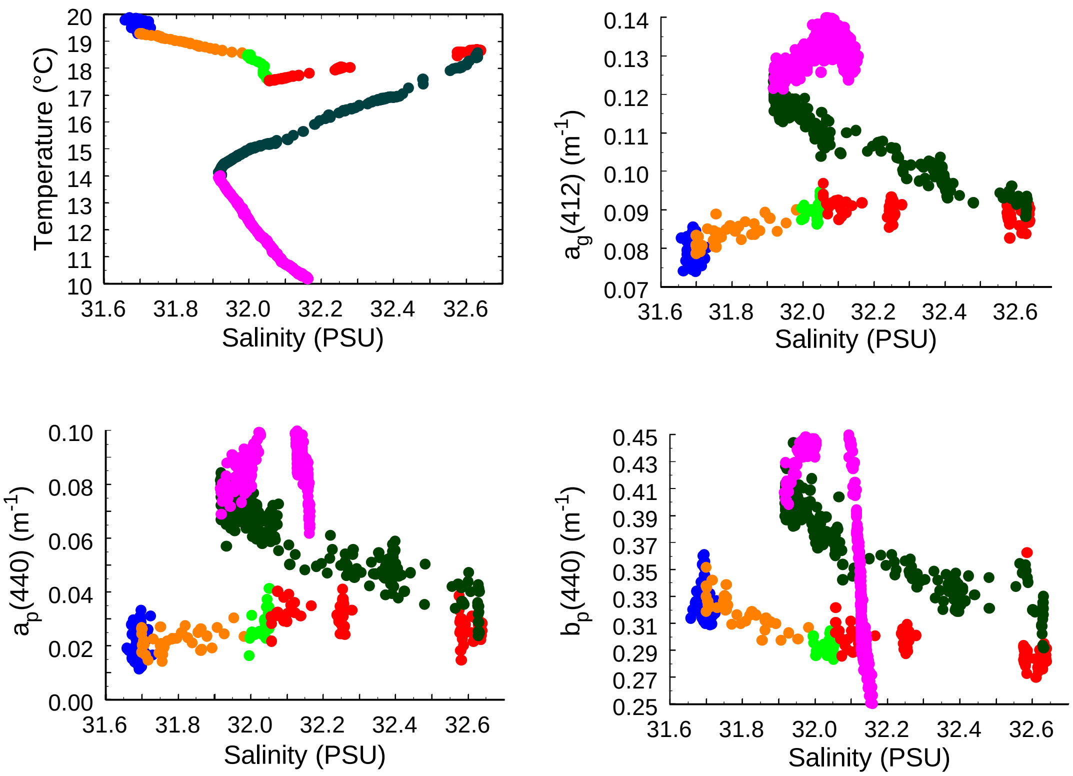

Figure 1. Regions of mixing are evident in the temperature-salinity relationships associated with a salinity intrusion. Plotting optical properties against salinity provide evidence that these properties are also redistributed in a similar manner by the mixing. This is evident in the absorption coefficients measured at the top (gold) and bottom (dark green) of the salinity intrusion. The scattering coefficient near the peak of the salinity intrusion was higher than would have been predicted based on a mixing line. This is evidence that other processes are still important in determining the distribution of optical materials.

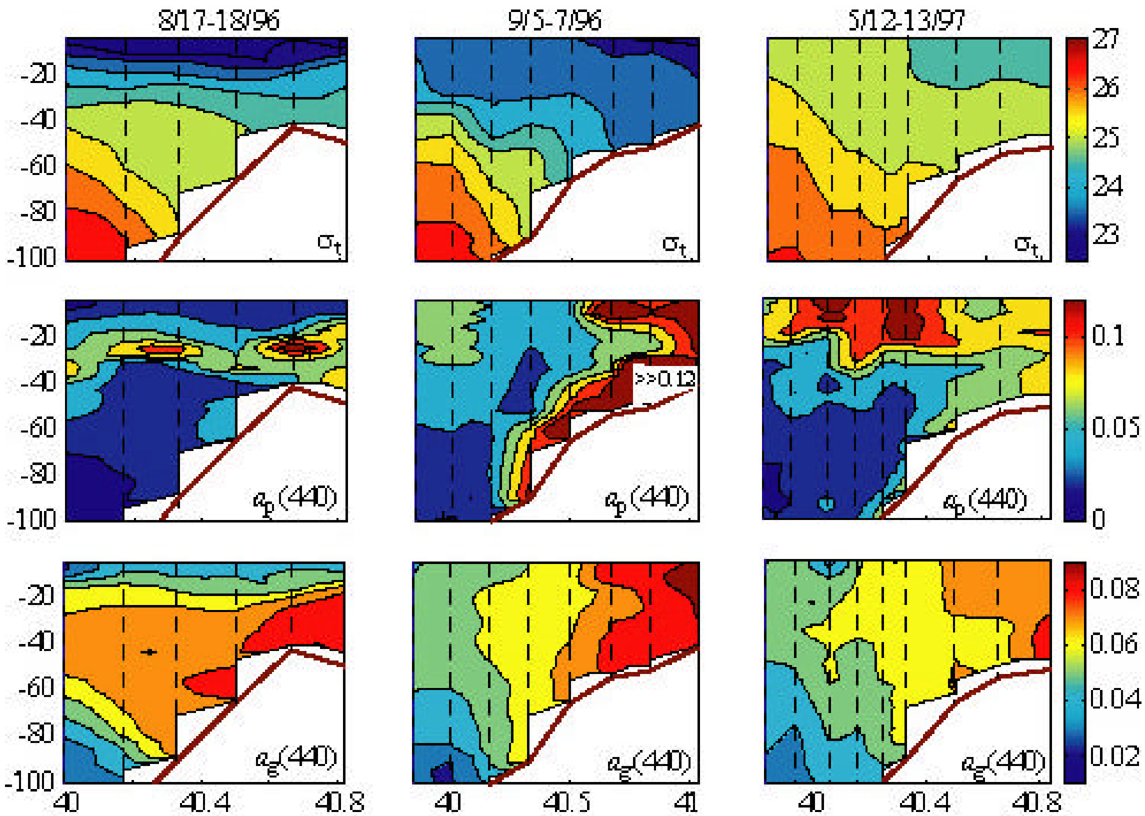

Figure 2. Horizontal sections of s_t, $a_p(440)$, and $a_g(440)$ associated with 3 cross-shelf transects during the two CMO experiments are provided. Decreased stratification and increased a_g values are observed after the passage of Hurricane Edouard (second set of panels). The increase in a_g values towards shore represent increased mixing of a bottom source of colored dissolved organic materials as the water depth decreases. Similar results are observed in the spring when storms are common in the region. The broken lines denote the location of sampling stations.

IMPACT/APPLICATIONS

The analysis shows that resuspension of bottom sediments by storms can introduce higher levels of colored dissolved organic material within the water column. Unlike the particles that settle back to the bottom the dissolved material will remain in suspension affecting the optical properties, and the performance of optical systems, for longer time periods. Developing an understanding of how optical properties are mixed across frontal boundaries, like those edges of the salinity intrusion, maybe useful in determining the age of features by using known coastal and off-shelf endpoints of the optical properties.

TRANSITIONS

Our data has been supplied to all investigators in the Coastal Mixing and Optics program that has expressed an interest in the data. It is being used by Dr. Sosik at WHOI, and Dr. Gardner at TAMU to provide detailed vertical structure of inherent optical properties and to provide a more comprehensive physical and optical time series of the region.

Data from the 1997 cruise has been supplied to Drs. Bricaud and Frouin to provide ground truth data for the Polder imaging system. It has also been made available to Dr. Yoder's group at URI and Dr. Campbell's group at UNH for studies related to OCTS imagery and ocean color remote sensing algorithms.

RELATED PROJECTS

This project is a continuation of Zaneveld and Pegau, Coastal Mixing and Optics, award number N000149510425 (ONR).

NASA SIMBIOS – optical data provided to NASA for validation and calibration data for the ocean color remote sensing platforms.

NASA SeaWiFS – the data is being used to test algorithms to invert ocean color remote sensing data.

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